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H1R RBH

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GB 1449209 A GB 1315918 A DE 004113231 A1
US 5173150 A

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(54) **Electromagnetically shielding printed circuit boards**

(57) A method of shielding a printed circuit board for use in an electronic circuit comprises the steps of placing an insulating layer 8 on a board 1 except over the area where a grounding land 4 and a connecting land 3 for electronic components are formed, placing an electromagnetic shielding foil layer 9 on the insulating layer, placing a solder resist 10 on the electromagnetic shielding layer to protect it, and connecting the electromagnetic shielding layer with the grounding land 4 through a flat package shaped jumper 11 to maintain the electrical level of the electromagnetic shielding layer at ground level. A copper foil is used as the electromagnetic shielding layer 9 in order to provide a low sheet resistivity and to secure long term reliability.

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FIG. 1

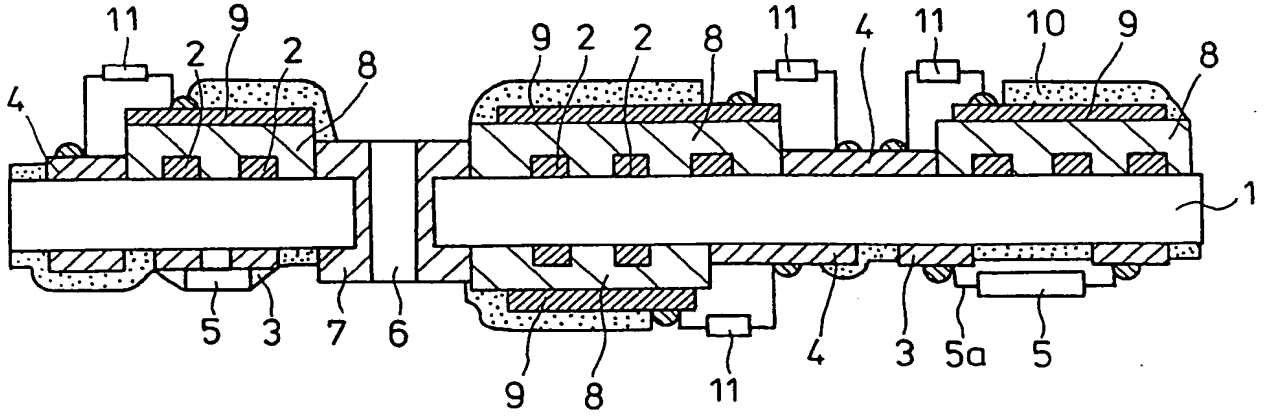

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FIG. 1

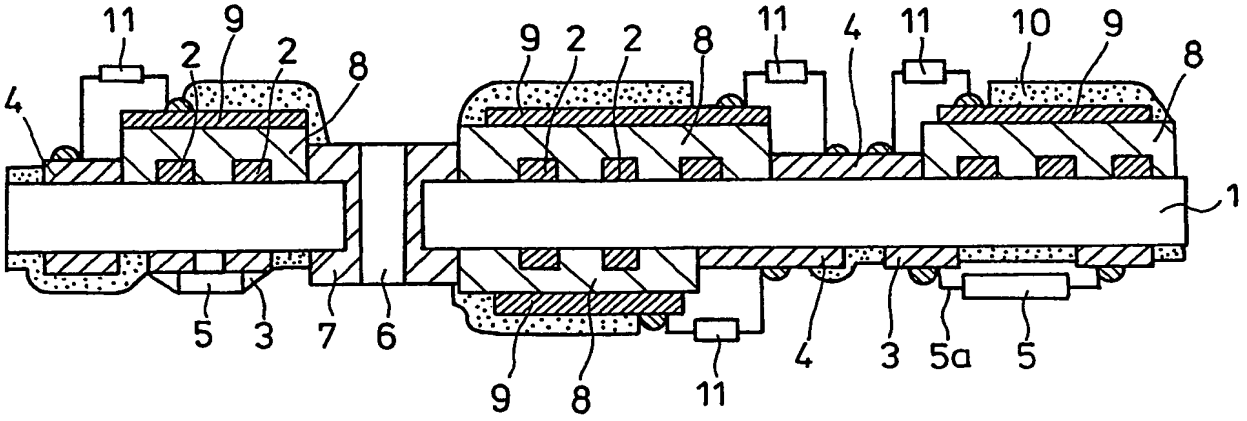


FIG. 2

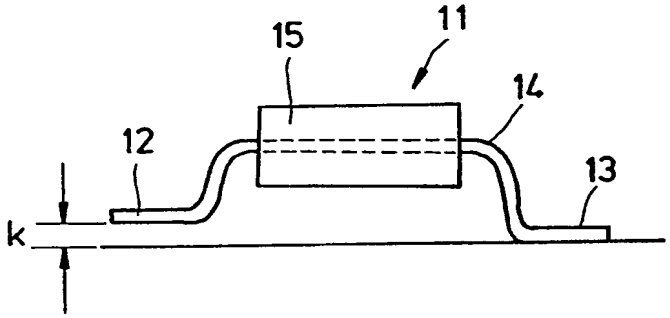


FIG. 3

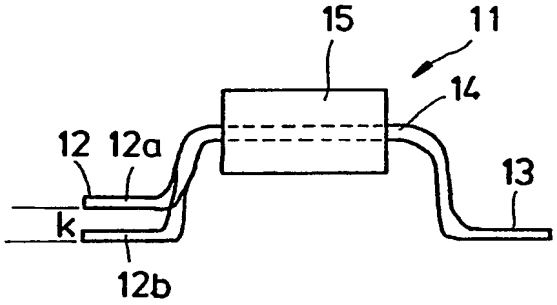


FIG. 4

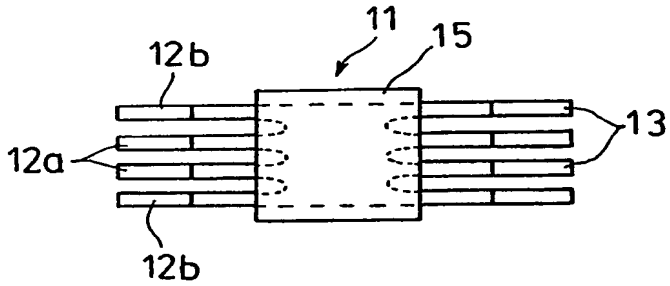


FIG. 5

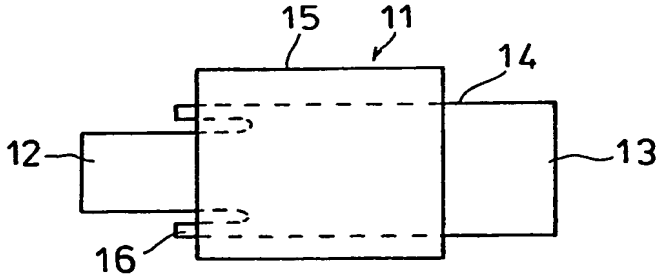


FIG. 6

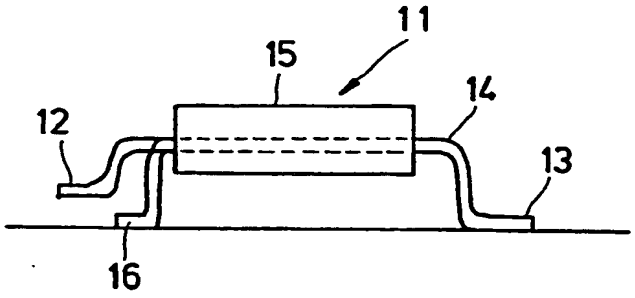


FIG. 7

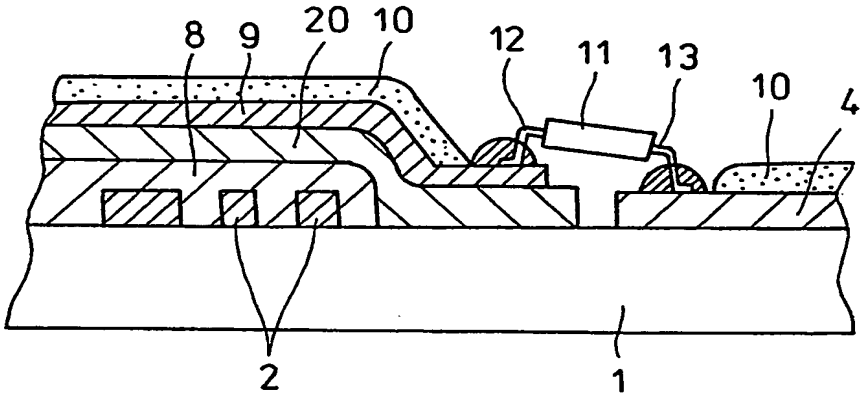


FIG. 8

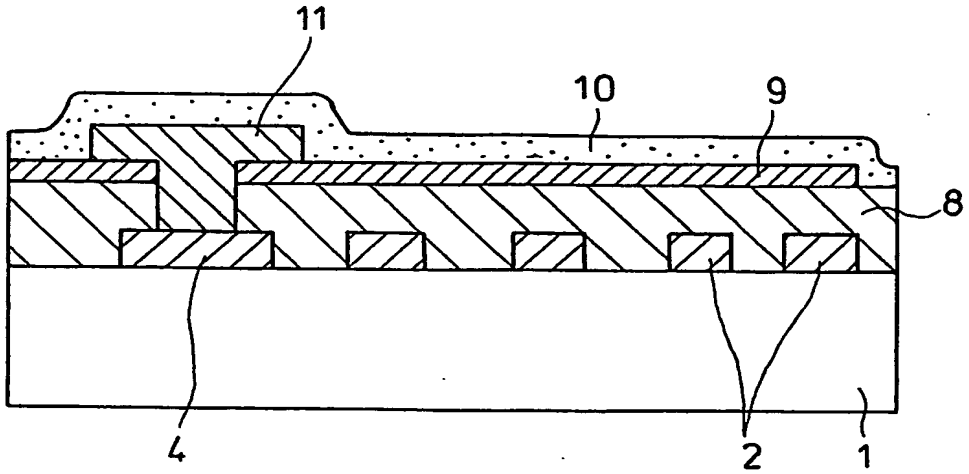


FIG. 9

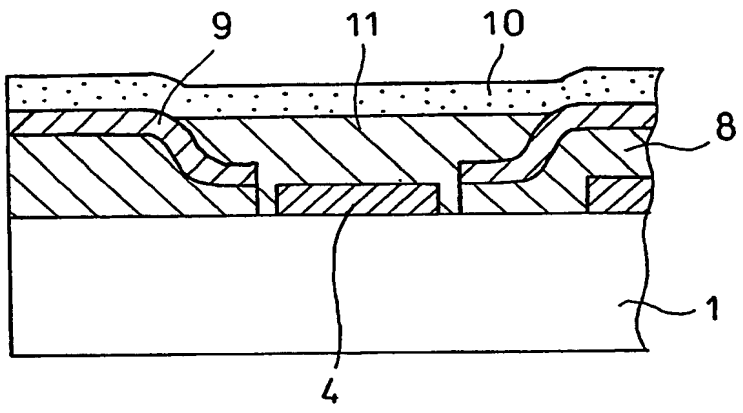


FIG. 10

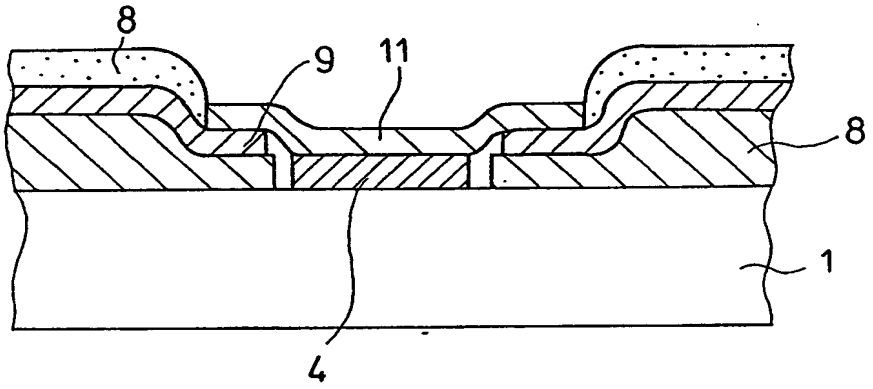
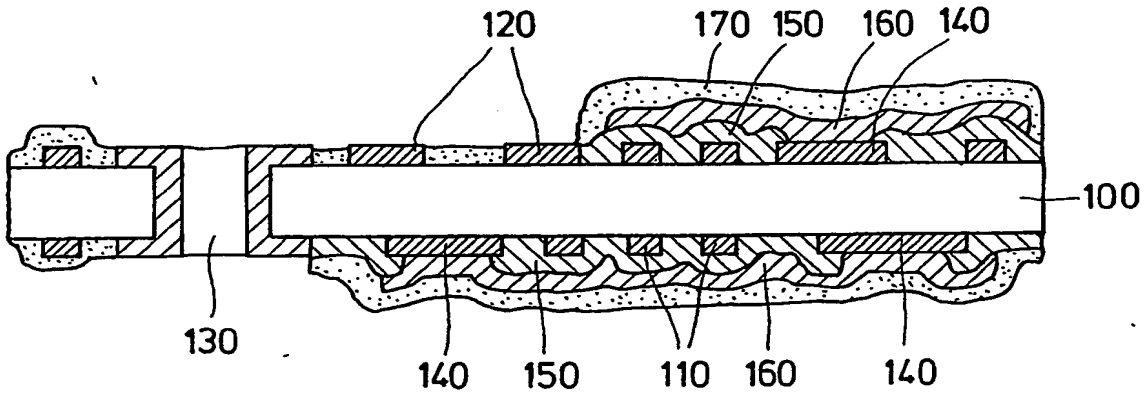


FIG. 11



"A PRINTED CIRCUIT BOARD AND METHOD OF MANUFACTURING SAME"

The present invention relates to a printed circuit board comprising an electromagnetic shielding layer, and to a method of manufacturing same.

In electronic equipment such as a computer and office equipment, in order to prevent equipment malfunction due to incoming electromagnetic waves and to prevent an outgoing electromagnetic wave causing a noise source, the housing is made of metal or a metallised layer is formed on the inner surface of the housing. Also in order to operate at higher processing speed and to improve reliability, it is now required to suppress electromagnetic noise from a printed circuit board used for the equipment.

In order to accomplish this purpose, electromagnetic interference prevention has been effected by coating a conductive resin paste on a conventional printed circuit board.

Figure 11 of the accompanying drawings is an illustration showing a conventional printed circuit board. Both a circuit pattern 10 and a connecting land 120 for an electronic component, which are formed by means to etch a copper foil, are provided on both sides of an insulation board 100. Reference numeral 130 is a conductive through hole connecting the circuit pattern placed on both sides of the board. Reference numeral 140 is a grounding land formed on a predetermined area on both sides of the board.

Both sides of the board 100 are covered with an insulating layer 150 except the area where both the connecting land 120 and the through hole 130 are formed. An electromagnetic shielding layer 160 consisting of a conductive resin paste is placed over the insulating layer 150. The electromagnetic

shielding layer 160 is coated on the insulating layer 150 of the board 100 by means of a printing method or the like. The electromagnetic shielding layer maintains contact with the grounding land 140 so as to provide an electromagnetic shielding effect by maintaining the voltage at ground level. Reference numeral 170 is a protective layer consisting of a solder resist covering the electromagnetic shielding layer 160.

By providing the electromagnetic shielding layer 160 consisting of the conductive resin paste, electromagnetic waves radiated from a circuit pattern 110 formed on the board 100 can be reduced. At the same time, equipment malfunction due to incoming electromagnetic noise can be prevented.

However, the conventional conductive resin paste, which has been used to form the electromagnetic shielding layer, does not have an adequate shielding effect because the conductive resin paste is made of a mixture of a conductive metal powder (for example copper) and a polymer so that the sheet resistivity is not small enough. Also a change of ambient temperature and/or humidity causes the deterioration of it so that the sheet resistivity becomes larger under long term use and the resistivity value becomes unstable. Further the reliability of the connection with the insulating layer 150 and the grounding land 140 tends to degrade.

The present invention seeks to provide a printed circuit board having a suitable electromagnetic shielding effect and long term reliability, and to provide its manufacturing method.

According to a first aspect of the invention, there is provided a printed circuit board comprising an electromagnetic shielding layer consisting of a copper foil laminated on one or both sides of a board

through an insulating layer except over that area or areas where electromagnetic shielding is not required.

An electromagnetic shielding layer consisting of copper foil has an adequate low sheet resistivity so that it has a suitable shielding effect. When the jumper is used to connect the electromagnetic shielding layer consisting of a copper foil with the grounding land on the board, the voltage level of the electromagnetic shielding layer can be maintained at the ground level so that the shielding effect can be secured. When a flat package shaped jumper is used, it can be placed on the board in the same manner as placing an electronic component.

According to a second aspect of the invention, there is provided a method of manufacturing a printed circuit board comprising the steps of placing an insulating layer on one or both sides of a circuit pattern-formed board, stamping a copper foil to cover the board except over that area or areas of the circuit pattern which does not require electromagnetic shielding, and placing the stamped copper foil on said insulating layer with adhesive.

According to a third aspect of the invention, there is provided a method of manufacturing a printed circuit board comprising the steps of placing an insulating layer on one or both sides of a pattern-formed board, placing a copper foil on the insulating layer, and removing the area or areas of the copper foil where electromagnetic shielding is not required on said board by means of etching.

As explained above, the present invention provides the method of manufacturing a printed circuit board having an electromagnetic shielding made of a copper foil and a stable shielding effect for long term use.

In order that the invention may be better

understood, several embodiments thereof will now be described by way of example only, and with reference to the accompanying drawings in which:-

Figure 1 is an illustration showing the cross-sectional view of the first preferred embodiment implementing the present invention;

Figure 2 is an illustration showing the side view of a jumper;

Figure 3 is an illustration showing the side view of another shape of a jumper;

Figure 4 is a plan view of Figure 3;

Figure 5 is an illustration showing the plan view of another shape of a jumper;

Figure 6 is an illustration showing the side view of Figure 5;

Figure 7 is an illustration showing the cross-sectional view of the second preferred embodiment implementing the present invention;

Figure 8 is an illustration showing the cross-sectional view of a different type of a jumper;

Figure 9 is an illustration showing the cross-sectional view of another different type of a jumper;

Figure 10 is an illustration showing the cross-sectional view of another different type of a jumper;

Figure 11 is an illustration showing the cross-sectional view of a conventional printed circuit board.

In each preferred embodiment to be described, corresponding components are given the same reference numerals and overlapping explanation has been eliminated.

Referring now to Figure 1, there is shown an illustration of a printed circuit board of the first preferred embodiment implementing the present

invention, in which a circuit pattern 2, a connecting land 3, and a grounding land 4 are pattern-formed on both sides of an insulation board 1. The circuit pattern 2, the connecting land 3 and the grounding land 4 are concurrently formed by printing, exposing and etching a copper foil laminated on the whole surface of both sides of the board. The connecting land 3 is to place an electronic component 5. Either a lead 5a of or the body of the electronic component 5 is directly reflow-soldered to the connecting land 3. The grounding land 4 is to maintain the voltage at ground level. Reference numeral 6 is a through hole to connect the circuit pattern 2 located on both sides of the insulation board 1. For this purpose, the hole 6 is filled with a conductive material 7.

An insulating layer 8 is placed on a predetermined area of the insulation board 1, on both sides of which the circuit pattern 2, the connecting land 3 and the grounding land have been formed. Then an electromagnetic shielding layer 9 is placed on the insulating layer 8. The insulating layer 8 and the electromagnetic shielding layer 9 are placed on the board except the circuit pattern where the electromagnetic shielding is not required. Referring to Figure 1, both layers are placed on the board 1 except the connecting land 3 to place the electronic component and the through hole 6 to connect both sides of the insulation board 1.

Hereunder the electromagnetic shielding layer 9 comprises the copper foil placed on the insulating layer 8. The electromagnetic shielding layer 9 is made of the copper foil so that the layer permits a lower sheet resistivity and secures an electromagnetic shielding effect. Further the copper foil does not deteriorate under excessive temperature/humidity conditions so that its reliability is extremely high

over long term use.

Reference numeral 10 is a solder resist, which is coated and hardened on the electromagnetic shielding layer 9 made of the copper foil. It behaves as a protection layer preventing the electromagnetic shielding layer 9 from peeling and oxidising.

A jumper connects the electromagnetic shielding layer 9 made of copper foil with the grounding land 4 on the board 1 so that the voltage of the electromagnetic shielding layer 9 is maintained at ground level.

Herein the voltage of the electromagnetic shielding layer 9 is maintained at ground level so that the electromagnetic shielding effect can be ensured. Also the electromagnetic radiation from the circuit pattern 2 of the board 1 and an incoming electromagnetic wave into the circuit pattern 2 can be firmly prevented.

There now follows an explanation of the manufacturing method of the preferred embodiment:

First the insulating layer 8 is placed on the board 1, on which the circuit pattern 2, the connecting land 3 and the grounding land have been formed. Then a one side adhesive-laminated copper foil is stamped to make clearance at the area that corresponds to the connecting land 3, the grounding land 4 and the through hole 6. In order to form the electromagnetic shielding layer 9, the copper foil is placed on the insulating layer 8. Then the solder resist 10 is coated over the electromagnetic shielding layer 9 to be a completed printed circuit board. In a component assembly process, the electronic component and the jumper 11 are placed on the board, and then their leads are reflow-soldered.

Figure 2 is an illustration showing the jumper

11. It is comprised of a conductive material 14, both ends of which are to be connecting leads 12 and 13, and a packaging material 15, which is plastic-moulded at the centre portion of the conductive material 14. It is formed into a flat package shape so that it can be handled in the same manner as the same shape of an electronic component, so the jumper 11 can be placed on the board along with the electronic components. This has the advantage that jumper placement can be automated.

The connecting lead 12 is soldered to the electromagnetic shielding layer 9. The connecting lead 13 is soldered to the grounding land 4 on the insulation board 1. The connecting lead 12 is formed so as to be the dimension k higher than the connecting lead 13 from the bottom. The dimension k corresponds to the height difference (for instance 100 μm) between the grounding land 4 and the electromagnetic shielding layer 9 on the insulation board 1. By forming the connecting leads 12 and 13 to correspond to the dimension k, the lead connection of the jumper 11 can be secured. Also, the forming prevents the leads from deforming.

Figures 3 and 4 are illustrations showing another example of the jumper 11. Each connecting lead 12 and 13 consists of four leads. Out of the four connecting leads to be connected to the electromagnetic shielding layer 9, the inner two leads 12a are formed so as to be dimension k higher than the outer two leads 12b from the bottom. For the printed circuit board shown in Figure 1, the lead 12a, which is dimension k higher than the lead 12b, is soldered to the electromagnetic shielding layer 9.

Such jumper 11, which has a plurality of connecting leads 12 and 13, is connected to the corresponding electromagnetic shielding layer 9 and

the connecting land 3 so that the connection reliability can be enhanced.

Figures 5 and 6 are illustrations showing another example of the jumper 11. The shape of the conductive material 14 is widely extended. The resistivity of the conductive material 14 can be subsequently lower so that the function of the jumper 11 is enhanced.

In this example, a supporting lead 16 locating outside of the connecting lead 12 to be connected to the electromagnetic shielding layer 9 is also provided with the same height as the lead 13. The supporting lead 16 secures the horizontal position of the jumper 11 so that stable placement of the jumper 11 can be made. Further, the jumper 11 is not limited to a flat package shape. The connection can be made by many means such as a conductive wire soldering, screw tightening and welding.

In Figure 7 there is shown a second preferred embodiment implementing the present invention. The circuit pattern 2 and the connecting land 4 are formed on only one side of the board 1. In this preferred embodiment, an adhesive layer 20 is placed on the insulating layer 8. The electromagnetic shielding layer 9 made of copper foil is placed on the adhesive layer 20. In this case, the adhesive layer 20 is extended to the board 1 because there is a large space between the circuit pattern 2 and the connecting land 4.

In this printed circuit board, the height difference between the electromagnetic shielding layer 9 and the grounding land 4 is less than 30 to 50 μm so that the off-the-shelf flat package type of jumper, having the connecting leads 12 and 13 at the same height, can be used. Thus the jumpers and the electronic components can be handled under the same

production process. This permits efficient automated component placement.

Figures 8 to 10 are illustrations showing other examples of the jumper 11, which connects the grounding land 4 on the board 1 with the electromagnetic shielding layer 9 made of copper foil. In Figures 8 and 9, a conductive resin paste is used as the jumper 11. After the electromagnetic shielding layer 9 consisting of the copper foil is formed, the jumper 11 is formed by coating the conductive resin paste. Then the solder resist 10 is coated to cover the electromagnetic shielding layer 9 and the jumper 11.

In Figure 8, the jumper 11, which forms a wide flange shape at the top, is contacted with the electromagnetic shielding layer 9. In Figure 9, a concavity is formed at the electromagnetic shielding layer 9. Then the jumper 11 is filled in both the concavity and the periphery of the grounding land 4. Therefore in both cases, the contacting area between the jumper 11 and the electromagnetic shielding layer and/or between the jumper 11 and the grounding land 4 becomes bigger so that the connection is secured and the sheet resistivity becomes smaller.

Figure 10 is an illustration showing a jumper 11 made of a thermal pressure adhesive type of an adhesive conductive film. It extensively adheres both the electromagnetic shielding layer 9 and the grounding land 4 so that the contact with the two portions can be secured.

It is further understood by those skilled in the art that the present invention is not limited to the foregoing preferred embodiments, so various changes and modifications may be made. For example, as the electromagnetic shielding layer 9, not only copper foil stamped to make clearance but also copper

foil without any mechanical modification to cover the whole insulating layer may be used. In the latter case, after the copper foil is placed, the area of the copper foil corresponding to the part such as the connecting land, where the electromagnetic shielding is not required, may be removed by means of etching. Then electronic components may be placed on the part. A copper-laminated flexible board may be used as the electromagnetic shielding layer. Further, an electrical circuit element such as an inductance, a capacitance or a resistance as well as the connecting land to be used for the electronic component placement may be formed on the area, where the electromagnetic shielding is not required, by means of the predetermined process to the electromagnetic shielding layer made of the copper foil.

Also as the electromagnetic layer, a copper foil, on which a high permeability metal foil such as nickel is laminated, may be used. This offers effective electromagnetic shielding to a wide range of frequencies from low frequency to high frequency. The electromagnetic shielding layer 9 made of copper foil may be placed on the area of the through hole 6 (refer to Figure 1) through the insulating layer 8 to provide the electromagnetic shielding effect.

CLAIMS

1. A printed circuit board comprising an electromagnetic shielding layer consisting of a copper foil laminated on one or both sides of a board through an insulating layer except over that area or areas where electromagnetic shielding is not required.

2. A printed circuit board as claimed in claim 1, wherein said electromagnetic shielding layer is a copper-laminated flexible board placed on the board, wherein the copper surface faces toward the outside.

3. A printed circuit board as claimed in either one of claims 1 or 2, further comprising a jumper to connect between the electromagnetic shielding layer and a grounding land on said board.

4. A printed circuit board as claimed in claim 3, wherein said jumper is formed as a flat package shape and is connected between said electromagnetic shielding layer and the grounding land during a placing process for electronic components on the board.

5. A printed circuit board as claimed in claim 4, wherein said jumper is formed as a flat package shape having different height contacting leads to correspond to the height difference between said electromagnetic shielding layer and the grounding land.

6. A printed circuit board as claimed in claim 3, wherein said jumper is made of a conductive resin paste or a conductive film to extensively connect said electromagnetic shielding layer with the grounding layer.

7. A printed circuit board substantially as hereinbefore described with reference to Figures 1 to 10 of the accompanying drawings.

8. A method of manufacturing a printed circuit board comprising: the steps of placing an insulating layer on one or both sides of a circuit pattern-formed

board; stamping a copper foil to cover the board except over that area or areas of the circuit pattern which does not require electromagnetic shielding, and placing the stamped copper foil on said insulating layer with adhesive.

9. A method of manufacturing a printed circuit board as claimed in claim 8, comprising the further steps of placing said copper foil on the insulating layer and connecting the copper foil with the grounding land of the board through a jumper.

10. A method of manufacturing a printed circuit board comprising the steps of: placing an insulating layer on one or both sides of a pattern-formed board, placing a copper foil on the insulating layer, and removing the area or areas of the copper foil where electromagnetic shielding is not required on said board by means of etching.

11. A method of manufacturing a printed circuit board as claimed in claim 10, comprising the further step of connecting said copper foil with the grounding land of the board through a jumper after said etching.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number

GB 9305545.2

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(i) UK Cl (Edition L) H1R (RAC,RBD,RBH)

(ii) Int Cl (Edition 5) H05K

Search Examiner

H COLLINGHAM

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES: WPI

Date of Search

26 APRIL 1993

Documents considered relevant following a search in respect of claims 1-11

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 1449209 (HONEYWELL-BULL) whole document	1,8,10
X	GB 1315918 (IBM) whole document	1,8,10
X	DE 00411323I A1 (MITSUBISHI) whole document	1,8,10
&	US 5173150 (KANAOKA)	

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

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P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

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